Stamping process and tools, applications especially to stamping of benches, and stamped articles, in particular seating benches obtained by such process and tools.

This invention relates to the technical sector of sheet metal stamping and to the products thereby obtained.

Stamping is generally known to be an operation which consists of converting a metal sheet by means of a press to an article or product exhibiting a certain specific shape or geometry.

The principle of operation of such a press is illustrated in Figure 9.

As shown diagrammatically in the attached Figure 1, a metal sheet to be stamped T is positioned above a punching die 4 held in position above a blank holder made up of two parts of symmetrical blank holders 3 (hereinafter referred to as "two blank holders" for the sake of clarity), front AV and rear AR (AV and AR designating, as illustrated in the attached drawing, the direction of advance of the metal sheet - the metal sheet moving from the "AV" *part, which marks the entry of the sheet into the press in the direction the "AR" part, which marks the point of exit of the metal sheet from the press, and each press or tool*

element will be thus identified, by its parts AV and AR, in accordance with the same convention, in what follows -

in the case of consecutive multiple stampings of a single metal sheet, for example, in order to produce repetitive series of stamped forms the total length of which is much greater than the width of the press, it not being possible of course to increase such width at will, for obvious considerations of cost), such punching die exhibiting as negative the geometric shape 5 intended to form a positive imprint on the metal sheet, when the press bed 1 and the bottom dies 2 and tool 10 having positive shape or geometry 5 are lowered and apply the metal sheet to the bottom die and then deform the sheet so as to assume geometry or shape 5 as the press continues to move downward.

The expert knows that when the press moves downward and comes into contact with the metal sheet T, the press begins by clamping the metal sheet, without deforming it, between the lower surfaces 7 of the bottom dies and the upper surfaces 8 of the blank holders.

Subsequently, as the press continues to move downward, it will be seen that the metal sheet is fastened in particular at the level of the gripping brought about by facing areas 9 and 9' of the bottom dies and blank holders. Downward movement of the metal sheet accordingly will cause slight sliding of the sheet before it is fully gripped between faces 7 (9) and 8 (9') and the plate will be blocked from translatory motion and will not be able to undergo deformation over the interval defined by the space between the blank holders.

The expert knows that thinning of the metal sheet then occurs, because the sheet is lengthened to assume the shape 5, as does also deformation, especially at the level of edges 9, 9'.

When the geometric shape 5 is sufficiently marked relative to the initial plane of the sheet there inevitably occur in area 9, 9' of the metal sheet, on the one hand tightening marks due to the imprint of edges 9 and 9', one of these marks remaining visible on the side which is to be the visible side of the finished product, and on the other defects due to elongation and simultaneous deformation, ones such as curls or slight folds.

Such marks are hardly acceptable in a finished product, especially in a finished product which is not scheduled to undergo an additional stage of deposition of a protective or decorative coating or the like.

In a great number of technical sectors the advantage of stamping consists of working with a metal sheet which will yield a finished product directly, with no additional treatment which would represent an additional stage and thus additional cost.

It should be noted, however, that stainless steel is known to be even more difficult to stamp than ordinary steel. It accordingly requires stronger clamping, but with an even greater risk of marking. Nevertheless, stainless steel still naturally represents a material of choice

for a great number of items of equipment, including vehicle seating benches or waiting room benches in general.

Hence the problem solved by the invention is that of eliminating the clamping marks and the deformation curls or folds arising during stamping of metal sheets in accordance with a "marked" punching die geometry relative to the initial plane of the metal sheet.

The term "marked" is used here to designate a geometry which imposes areas of deformation which are large and/or near each other. Such is the case with the great majority of stamping operations.

One particular case, but absolutely not a restrictive one, in which this problem is particularly acute relates to stamping of a metal sheet to form benches for seating travelers, for trains, waiting rooms, airports, subways, and the like.

Such benches are illustrated diagrammatically in the attached Figure 2. It is to be seen that the metal sheet T has been stamped so as to produce seating form openings or imprints 11, 12, etc., separated by an interval i. In the prior art the ability existed of manufacturing benches of this type by stamping, but ones without hollow forms, something which naturally caused wholly unacceptable sliding of passengers forward or sideways. The stage had also been reached of manufacturing the hollow molds by stamping, but with too great an

interval between the imprints, a process also accompanied by formation of folds, marks, and curls if an attempt was made to reduce this interval, as will be explained below.

The advantage of technology of this kind is to apply stamping to form stamped articles of all types, such, to give a non-restrictive example, as benches with, especially, 2, 3, 4, 5,6, 7, or even eight or more, seats. Such seats require precisely consecutive stampings as explained above.

Such benches manufactured by stamping are clearly less costly than molded plastic benches. As can be seen below, the invention also makes possible the stamping of plates of plastic or composite materials.

The hollow forms are, of course, progressive and the set of bench forms should be suitably convex for the sake of seating comfort, as shown in the attached Figure 3. These forms are, of course, obtained by means of the precise geometry 5 of the punching die 4 of the corresponding tool 10. The interval i is defined more precisely in Figure 3, in which i represents the length of the plane section 117 separating the two hollow (or rounded) sections 115 and 116.

If the interval i is too small, the clamping and deformation marks described above are produced during the conventional stamping processes. But precisely a small interval i is required in order to seat a maximum number of passengers over a minimum length.

Among other things the length is determined by the maximum moving dimensions of trains or coaches. The interval i often required is such that with conventional tools it results in the marks referred to above.

In addition the metal sheets T used are sheets which preferably have already been covered with a facing before stamping, which is preferably definitive, and it will no longer be possible to make these marks disappear later in this advantageous case.

The object of the invention is to eliminate these disadvantages.

Further features and advantages of the invention will appear more clearly upon reading of the following description and by reference to the accompanying drawing wherein:

- Figure 1 represents a stamping press and tools of the prior art in diagrammatic form;

- Figure 2 illustrates, in diagrammatic form, the general form of a bench of stamped metal sheet representing a particular, non-restrictive, example of application of the invention;

- Figure 3 represents, in section, the contour of the benches in diagrammatic form before they have been produced;

- Figure 4 illustrates the general principle of the invention, in the form of a lateral section through a set made up of a punching die and AV and AR blank holders;

- Figure 5 illustrates adaptation of the general principle of the invention as presented in figure 4 to manufacture by stamping of benches having comfortable recessed seats spaced at small intervals i, in the form of a transverse left-to-right (G-D) section of the press and stamping tools;

- Figure 6 illustrates, in a perspective view, the outline of a set of blank holders AV and AR and punching die suitable for manufacture of multiple-seat benches, in particular ones with 6 seats;

- Figure 8, consisting of Figures 8a (bottom die) and 8b (punching die) illustrates, in a perspective view a non-restrictive example of application of the invention to a set of blank holders AV and AR and punching die suitable for manufacture of multiple-seat benches, ones with 6 seats in particular, in one advantageous embodiment of the invention a set of bottom dies, AR blank holder, and punching die permitting modification of the "pitch" of the stamping operation.

- Figure 9 illustrates in cross-section a skeleton diagram of a prior-art stamping press which may be used as claimed for the invention, provided that appropriate tools are employed. In this conventional press 600 designates the sliding mechanism, 900 the bottom die, 700 the punching die, 950 the blank holder, 800 the bed (stationary), and 980 the bar stands, F1 and F2 indicating the conventional relative movements.

The examples illustrated in Figures 1 to 9 are of course to be understood as being non-restrictive.

As can be seen in Figure 4, the invention relates very generally to a stamping process in which the rear blank holder (AR) 20 is widened toward the rear and is geometrically adapted to the level of the area 14, that is, preferably the area adjacent to the punching die, in order to reproduce at least one part of the form created by the punching die 4 in its AV part.

The AR blank holder may also by preference reproduce exactly one-half of the AV form of the punching die, or even more than one half, up to all of the form created by the punching die, but the set would be needlessly expensive and less easy to handle in the process conducted in consecutive steps to be described below.

Similarly, the AV blank holder 30 may have a slightly convex surface or contour 8 facilitating the deformation transition from the metal sheet toward the punching die. This may be an advantage in certain applications.

In the most general embodiment of the invention, the rear blank holder AR 20 is widened toward the rear relative to the dimensions of the prior art and on the end adjacent to the punching die (that is, the front end of the rear blank holder) is convex, that is, has a shape which permits progressive deformation of the metal sheet in depth, over a greater blank holder length, in place of the right angle of prior-art blank holders.

By way of preeminent preference, but not obligatorily, the front blank holder (AV) 30 is equally widened (toward the front) but its geometry requires no adaptation, that is, its surface 8 remains level but is widened toward the front relative to the customary dimensions of the prior art.

While wishing not to be restricted by any theory, the Applicant does believe that adaptation of the AR blank holder to at least one part of the geometry of the form created by the blank holder in its AV part makes it possible to render the clamping more progressive while better distributing the stresses applied by the press to the metal sheet, in terms both of surface and of time. The metal sheet would accordingly then be better able to adapt to the stresses and would be deformed without developing either clamping marks or curls or folds, even in the case of forms of "marked" geometry as defined above.

Widening of the AV blank holder 30 allays the same concern over better distribution of clamping stresses and then deformation. This widening of the AV blank holder 30 is less critical than adaptation of the AR blank holder 20, but does represent a favorable characteristic in a preferred embodiment of the invention.

One important advantage of the invention, aside from elimination of clamping marks and folds or curls, one which was brought to light at a time when it was not part of the technical problem initially formulated, is that it is possible to bring about very great reduction in pressure before it is applied by the press.

For a given stamped product, such as a six-seat bench as described below, the prior art makes use of a force of around 500 tons, while the invention is content with employing 150 to 300 or 350 tons for the same metal sheet.

The expert will appreciate the great industrial benefit of this advantage, particularly in terms of investment.

In an especially preferred embodiment of the invention, geometric adaptation of the AR blank holder represents half the form created by the punching die in its AV part.

Figures 6 and 7 illustrate non-restrictive examples of the invention, ones suitable for manufacture by stamping of multiple-seat benches, such as benches with two to six or more seats.

The perspective view in Figure 6 shows that the AR blank holder 100 in this particular non-restrictive embodiment reproduces one-half the seat form created by the punching die 120 in its AV part. However, in a less preferred alternative embodiment, the blank holder 100 could reproduce only a part, less than half, of the seat form of the punching die.

Within the framework of the general process claimed for the invention, the AR [rear] blank holder could also reproduce more than one-half, up to the entirety, of the form created by the punching die, but the whole would be needlessly costly and not as easy to manage in the process made up of consecutive steps which is described below.

Between the AR blank holder and the punching die 120 there is an area whose geometry has been adapted for reproduction of the desired form of interval i as defined as necessarily present between two consecutive seat forms.

The AV [front] blank holder 110 has been widened toward the front as indicated above as a non-mandatory option, but as can be seen from this example its profile 8 remains horizontal.

Figure 7 illustrates the process claimed for the invention.

It can be seen that the metal plate is positioned so as to obtained a first stamping form or "starting form." The metal sheet which has undergone this initial stamping is then displaced toward the "rear" and the "starting form" is repositioned on area 130 of the blank holder AR 100; a second stamping is then carried out, and so forth until, for example, six stampings have been produced.

Figure 7 shows that the blank holder AR 100 reproduces in its part B one-half of the seat stamping, identical to the half-form A of the punching die 120 in its AV part, the arrow indicating the direction of movement of the metal sheet step by step.

It is also to be seen that the tool has between blank holder 100 and punching die 120 a shoulder 150 which reproduces the interval i which must be present between consecutive seat stampings.

The expert will see that it is at this level that all the advantages of the invention are obtained. In particular, the half-stamping contour of the blank holder AR 100 allows reduction of the constraints to which the metal sheet is subjected (consequently, in addition to the stamping pressure); the set as a whole permits reduction of interval i to small values, of the order of 1 to 3 or 5 cm for metal sheets measuring 15/10 mm or even 12/10 mm or even 10/10, 8/10, or 6/10 mm, something which was impossible in the prior art without

marking and without folds or curls. In the prior art, that is, with a tool as shown in Figure 1, the smallest interval i that could be achieved was 3 to 10 cm for a 15/10 metal sheet and 5 to 12 cm for a 12/10 mm metal sheet, and this without the ability to eliminate the disadvantages referred to.

The invention accordingly allows use of a thinner metal sheet for a given assigned interval i; this represents a significant saving of material.

As we have seen, the invention also permits reduction of the interval with a metal sheet of equal thickness.

Another advantage claimed for the invention is production of smooth convex forms at the level of the interval, while in the prior art a level area is always found at this location.

It is claimed for the invention that it is even possible to reduce the interval i to zero without occurrence of folds or marks or curls. Forms are then obtained whose recesses 115, 116 are exactly adjacent and so form a rounded area with no level part 117 between each form, for example between each seating form 11, 12 if a bench is involved.

The invention accordingly enables the expert to employ these two parameters, interval and thickness, to effect the best possible accommodation to an order placed by his customer.

It is important for the metal sheet to rest after initial stamping on part B of the blank holder 100 in every stamping process (in this instance part B represents a half-form); if the metal sheet does not rest on this base, it is bent during successive advances and stampings.

The expert will understand that at least one part of the base part B might be replaced with other bearing means, such as friction rollers, etc, but the whole benefit of the invention is obtained when the blank holder AR 100 reproduces at least one part (in figure 7, one-half) of the impression made by the punching die 120.

In a preeminently preferred embodiment, the stamping process includes a metal sheet preforming step, as illustrated in figure 5.

The tool, punching die 4 and bottom die 10, and also the metal sheet, are shown here in cross-section.

In the best embodiment of the invention, and in the non-restrictive embodiment which is given as an example, the metal sheet is preformed by means of a bending machine.

However, the machine permits use of a preform which is simplified in comparison to the one which was mandatory in the prior art.

In a first preform embodiment the metal sheet is preformed along line a, b, c, rounded part d, e, f. All the sections are rectilinear, except for the curved part d.

In the prior art its was mandatory to preform the metal sheet by following the curvature of the seat, something which represented 84 operations on the folding machine in the example.

It is claimed for the invention that it is possible to use a preform comprising essentially straight sections a, b, c, e, and f, and a single rounded part d, the aggregate representing no more than 19 folds rather than 84.

It is to be noted that the set of folds between sections b and c alone represents 14 plies.

The invention also covers a first alternative in which the preform is formed in (rectilinear) sections a, b, c, d, g.

The invention also covers a second alternative embodiment in which the preform would be made up of sections a, h (rectilinear), d, e, f.

The invention also covers a third alternative embodiment in which the preform would be made up of sections a, h (rectilinear), d, g (rectilinear).

As can be seen, these three alternative embodiments again reduce the number of folding operations and accordingly improve the cost effectiveness of the process.

It is claimed for the invention that the metal sheet is positioned (as shown in Figure 7) without concern over aligning it vertically with the punching die and bottom die. The metal sheet may, for example, be offset some distance from vertical alignment. The press is then lowered slowly and the metal sheet is allowed to center itself on the tool.

The invention also creates the prospect, which was not part of the technical problem initially formulated, and so is surprising, of modifying the "pitch" imposed by the tool.

In the prior art, if it was desired to modify the stamping pitch, for example, in order to adapt a given type of product to orders coming from different customers who might require different dimensions, there was no other resource than dismounting the entire tool and replacing it with a new tool. Hence it was necessary to have as many tools as there were different pitches, and it was necessary also to handle entire sets of tools.

In contrast, as a result of the original concept of the blank holder AR, punching die, and bottom die claimed for the invention, as can be seen in Figure 8, the pitch may be modified at will by designing the tool in two separate parts by means of a transverse cut (that is, perpendicular to the direction of advance of the metal sheet), it forming the base tool at minimum pitch, and then by deducting from the desired pitch modification value E the two

parts of the tool thereby created by this separation, and by inserting into the gap E a suitable set of four dismountable pieces called shims, of bottom die 460, punching die 480, and blank holder 490 and 420.

These pieces may be fixed in position by any mechanical means, such as bolting, etc.

The advantage of this option lies in the fact that a single tool and one or more sets of such shims make it possible to adapt to each of the standards or customary practices of the target commercial areas rather than change the tool as a whole.

The invention also covers the tool as described, suitable for manufacture of benches with several seats, especially from two to six or eight or more requiring several consecutive seat forms or imprints 11, 12 separated by interval i, characterized in that, for it to be possible to modify the stamping pitch at will, the tool is designed in two separate parts by means of a transverse cut (that is, a cut perpendicular to the direction of advance of the metal sheet) at the level of the middle of the punching die (4, 120), which forms the base tool at the minimum pitch, it being possible for the parts to be separated from each other by the desired pitch modification value E, and in that the tool comprises one or more sets of four removable pieces called bottom die 460, punching die 480, and blank holder 490 and 420 shims suitable for insertion as an appropriate set into the interval E.

Among other things, the invention relates to stamping of all pieces similar to those of the example described, and in particular to any piece exhibiting similar repetitive imprints, but also to stamping of pieces of thin sheet metal, even non-repetitive stamping, in which marking, folding, or curling problems arise.

It is also possible to use holes directly in the "bottom" of the bench, that is, between areas 10 and 11 of the bench, for evacuation of rain water, in particular by means of a suitable imprint at the bottom of the bottom die relative to the punching die.

The invention permits stamping of metal sheets of different common thicknesses, by applying, as stated, a very low pressure, of the order of one-half the pressure generally applied, and also stamping of metal sheets of various common or stainless steels, or various common alloys, having a temporary lining, provisional or definitive, or under a finish layer, or again to effect stamping of plastic or composite plates of any type.

The press and the tool may be a heating press, depending on the material to be treated.

The invention covers the stamping process which has just been described, as well as the corresponding tools and corresponding preforms, along with the articles and products thereby obtained.

The invention also covers the stamping process which has just been described, as well as the corresponding tools and corresponding preforms, along with articles and products thereby obtained, adapted by the expert by conventional methods to stamping of products and articles of all forms compatible with the teaching of this description.

The expert will know how to adapt the invention to alternatives and options which will become directly apparent to him and to which the invention also relates.